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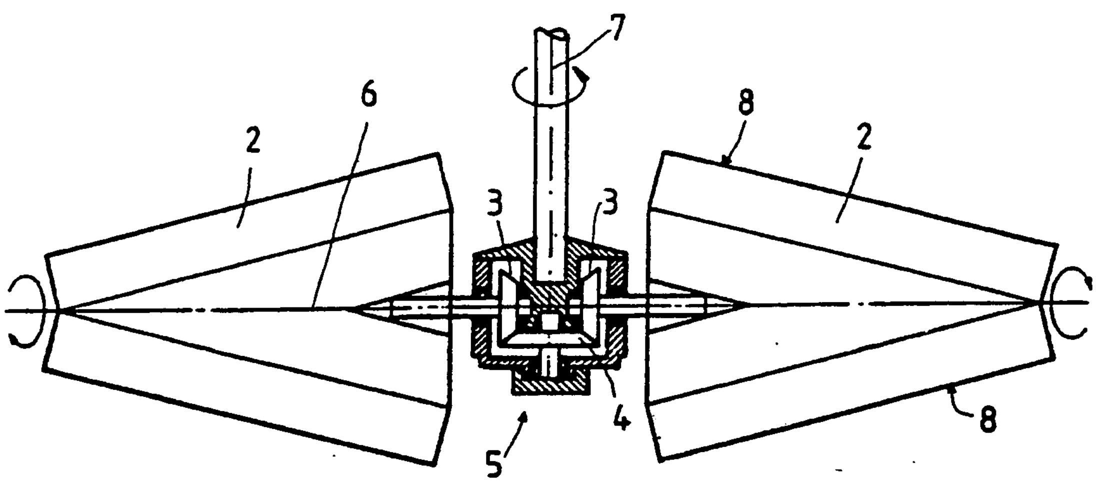

(57) Abstract

In that, in a double-acting stirring unit with a drive shaft (1) and stirring blades (2) placed on this which have been evenly distributed around the drive shaft (1) with which their longitudinal axes from a predetermined angle of 45-90°, where the stirring blades (2) have been placed in a circle and in pairs opposite to each other, where each stirring blade (2) has been rotary embedded around its longitudinal axis as a first axis of rotation, where each stirring blade has been rotary embedded near the drive shaft (1) axis which constitutes another axis of rotation, where the beddings of all the stirring blades (2) in each circle of stirring blades (2) are attached to the drive shaft (1) for rotation along with same around the other axis of rotation, and where all the stirring blades (2) in each circle through a gear wheel (3) each are in mesh with a joint gear wheel, the joint gear wheel (4) is freely rotary embedded around the drive shaft (1) around said other axis of rotation, and that each stirring blade (2) has been rotary displaced in relation to the neighbouring stirring blades (2) and has a cross section at right angles to its longitudinal axis or the first axis of rotation of rounded or angular S-like shape, a stirring unit is obtained through simple means in which the stirring blades are both rotated around the drive shaft and around their own longitudinal axis, a fact causing a compulsory axial and radial transport of the medium which is stirred.

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A double-acting stirring unit.

The invention concerns a double-acting stirring unit with a drive shaft and stirring blades placed on this which stirring blades have been placed evenly distributed around the drive shaft with which their longitudinal axes from a predetermined angle of 45-90° where the stirring blades have been placed in a circle and in pairs opposite each other where each stirring blade is rotary embedded around its longitudinal axis as a first axis of rotation, where each stirring blade is rotary embedded near the drive shaft axis which forms another axis of rotation where all the bedidngs of all the stirring blades in each circle of stirring blades are attached to the drive shaft for rotation together with this around the other axis of rotation, and where all the stirring blades in each circle through a gear wheel each mesh with a joint gear wheel.

The double-acting stirring unit to the invention is characteristic in that the joint gear wheel is freely rotary embedded around the drive shaft around said other axis of rotation, and that each stirring blade is rotary displaced in relation to the neighbouring stirring blades and has a cross section at right angles to its longitudinal axis or first axis of rotation of rounded or angular S-like shape. Thus, it is achieved that some of the stirring blades of the stirring unit will at all times be compulsory rotated by other of the stirring blades through the joint gear wheel which causes a compulsory axial and radial transport of the medium upon which the double-acting stirring unit performs its stirring operation. Due to the rotating movement of the blades, tangential or round going currents are also generated in the stirring medium. Said currents also render the use of secondary current breakers redundant in the container in which the stirring operation is performed, a fact which is particularly significant when stirring in low viscous liquids.

Due to the S-like shape, the stirring blades will begin to rotate around their own axis when the drive shaft rotation commences, and the S-shape is characteristic in that their

movement through a liquid or through the passage of a liquid past the stirring blades will offer more resistance than the liquid flow than on the other side of each stirring blade rotated against the liquid flow. Further, it is achieved that the ratio between the axial and the radial velocities in the stirring medium may be almost constant so that a change in the drive shaft number of revolutions will not entail any changes other than that the liquid velocities and thus the stirring intensity will change correspondingly. This in turn entails that the stirring unit will be equally suitable for high and low viscous liquids.

In that the course of each stirring blade has converging side edges away from its bedding point at the drive shaft, the rate of flow velocity generated by the stirring operation at the particular points of the stirring medium will be more uniform, i.e. will have less difference than if the stirring blade side edges were diverging or parallel.

In that the side edge convergence of each stirring blade for a particular S-shape and a particular stirring medium has been adapted so that the sum of the velocity of each side edge point around the first and around the second axis of rotation counting vectorially is constant, it is achieved that the stirring medium well get the same resulting velocity throughout the medium touched by the stirring blades, i.e. both close to the drive shaft and far from the drive shaft, thus causing the stirring medium coming into contact with the stirring medium to get the same energy pulse throughout the part of the stirring medium coming into contact with the stirring blades.

Due to this even distribution of the energy in the stirring medium, a comparatively low power consumption is achieved for the stirring unit in relation to the stirring intensity occurred.

In that each stirring blade in a circle of stirring blades which may in each circle be in a number of at least four where the cross section of each stirring blade has been turned 90° in relation to the neighbouring stirring blade

cross section positions in a circle of four stirring blades, and where the cross section of each stirring blade has been turned 60° in relation to the neighbouring stirring blade cross section in a circle of six stirring blades, has been given rotation opposite to the neighbouring blade rotation through the joint gear wheel, we shall obtain the same uniform distribution of the stirring intensity but a higher mixing effect in the area for each circle of stirring blades. The cross section shape of the blades which when meshing with the joint gear wheel are rotated for instance clock-wise will then be a reflection of the cross section of shape of the opposite rotating bladings.

In that the stirring unit has several circles of stirring blades consecutively placed on the same drive shaft, it is achieved that the stirring unit may be used in containers or pipes of a high length: diameter ratio with uniform distribution in the stirring intensity through the entire length of the pipe section of the container.

The length and S-shape of each stirring blade has, of course, been adapted so that the torque transmitted through the joint gear wheel in a circle of stirring blades is higher than the torque required for carrying the other stirring blades past their rotation dead centre position with a view to the friction in the meshings for a circle of stirring blades and the friction in the stirring medium.

In cases in which during the stirring operation all the stirring blades rotate the same way viewed e.g. in their longitudinal direction towards the drive shaft, it has turned out that there will be a faint pumping effect from the constantly driving stirring blades in the stirring medium. This pumping effect in the drive shaft direction may be increased by mounting several circles of stirring blades mounted after each other on the same drive shaft with the same direction of rotation. This phenomenon may e.g. be used in a transport pipe for the stirring medium where the stirring unit may be inserted with its circles of stirring blades in the transport pipe, thus generating a mixing operation as well as

a certain amount of moving of the stirring medium in the drive shaft direction. This faint pumping effect would seem to cease altogether in cases in which each stirring blade in a circle of stirring blades has been given rotation opposite the rotation of the neighbouring stirring blades through the joint gear wheel.

Rather than placing the stirring blades on a joint drive shaft, the stirring blades may be placed embedded in a joint pipe, each with its longitudinal axis course radially inward and with its gear wheel placed at the pipe wall or possibly outside it engaged with a crown wheel rotary embedded around the pipe for transmission of the rotation of the constantly driving stirring blades to the stirring blades to the stirring blades driven when a liquid is pumped through the pipe. Thus the liquid will be mixed in the pipe during the passage of the pipe section by the radially placed stirring blades. If so required, the toothed rim placed around the pipe may be put into rotation by a motor placed outside the pipe for increase of the stirring effect of the pipe.

The principle of the S-shaped stirring blades and the joint gear wheel in mesh with the gear wheel of the stirring blades in each circle of stirring blades may also be applied in connection with wind or hydraulic power machines for conversion of the kinetic energy of the wind or of the water into mechanical energy. Here, you let the particular S-shaped vanes be rotary displaced from its neighbouring vane in the circle where the rotary displacement is +90^{o} in the case of four-vane circles and +60^{o} with six-vane circles, etc., and where all the vanes are connected with the joint gear wheel for synchronization of their movements and for power take-off of the mechanical energy generated by the blades. Thus, we shall get a wind or hydraulic power machine where the blades are rotary around their own longitudinal axis only, but not around the take-off shaft axis, thus avoiding the powerful inertia forces connected with vanes rotating around the take-off axis. In that the vanes are also in this case converging from the joint gear wheel and out towards the tips of the vanes, the

vanes may be dimensioned much easier than usual because it is not necessary to pay very much attention to the centrifugal forces which are otherwise usually dimensioning along with the bending moment of the particular blades. A thus designed wind or hydraulic power machine has, unlike conventional driving engines, no need of adjustment of vanes in relation to the strength of the wind or the water flow. Conventional systems are made in such a way that the vanes are being put more and more on edge with a rising wind force or water flow. The interaction between the constantly driving rotary vanes and the driven rotary vanes will ensure that the resulting moment will be constant so that the number of revolutions for the particular rotary vane will remain constant, even at high wind or water velocities. The risk of any such driving engine racing is thus eliminated. The driving engine should only be cut out when the wind or water forces become so powerful that they constitute an excessive action on the supporting structure of the actual driving engine. At very high wind or water flow velocities, such that a driving machine may appropriately be designed so that two, or a multiple of this, of the rotary vanes may be put parallel with the others, thus reducing the flow action to a minimum, and the wind or hydraulic power machine will stop.

In the following the invention is described in more detail in connection with some type examples and with reference to the drawing, in which

Fig. 1 shows a stirring unit with two pairs of stirring blades which have converging side edges, and which have, viewed from their free blade end, the same rotation,

Fig. 2 is a side view of the stirring unit shown in Fig. 1, partially in section,

Fig. 3 is a section along III-III in Fig. 1 through a stirring blade,

Fig. 4 is a stirring unit as a schematic side view with two pairs of stirring blades having converging side edges, and which, viewed from their free blade end, have in one pair rotation opposite to the blades of the other pair,

Fig. 5 is a stirring unit with circles of stirring blades,

the beddings of which all rotate together with the drive shaft, and whose joint gear wheel placed freely rotatable around the drive shaft axis is in mesh with the gear wheel of the stirring blades in both circles of stirring blades,

Fig. 6 is a wind or hydraulic power machine in the form of a windmill from a front view with two pairs of S-shaped rotor blades stationarily embedded, and whose rotation is synchronized by the joint gear wheel which also serves as output shaft from the windmill stationary cap.

Fig. 7 is a side view and partial section of what is shown in Fig. 6,

Fig. 8 is the drive medium flow around an S-vane in a position near its dead centre position where it will yield its smallest torque,

Fig. 9 is the S-vane near the position at which it will yield its highest torque to the joint gear wheel,

Fig. 10 is an S-shaped stirring blade/vane of the Savonius type,

Fig. 11 is an S-shaped stirring blade/vane of the anemometer type, and

Fig. 12 is a stirring blade with parallel side edges and a stirring blade with diverging side edges.

Figs. 1 and 2 show a stirring unit with a drive shaft 1 carrying a single circle of stirring blades 2 of an S-like cross-section shape. Each stirring blade 2 has a gear wheel 3 in mesh with a joint gear wheel 4. All the gear wheels 2,3 are rotary embedded in a bearing housing 5 attached to the drive shaft 1. Through the drive shaft 1 rotation of the bearing house and thus of the stirring blade axes 6 in a stirring medium, the stirring medium will, as mentioned before, due to the S-like shape of the stirring blades 2 give the stirring blades and thus their gear wheel 3 a rotation in the bearing housing 5. An example of an S-like blade cross section is shown in Fig. 3. Other blade cross sections may, of course, also come into the picture as long as their shape will cause the stirring blade half moved the same way as the stirring blade axis all times to offer less resistance to its

movement in the stirring medium than the stirring blade half moved opposite the stirring blade axis direction of movement. The stirring blade axes 6 constitute the first axis of rotation of the stirring blades while the drive shaft axis 7 constitutes the other axis of rotation.

Other S-like cross section shapes include the anemometer and Savonius vane blade shapes, see Figs. 10 and 11.

As shown, the bedding of the stirring blades may be alone in the bearing housing 5 radially innermost but also a bedding radially outermost in a round-going ring not shown which may be appropriate, e.g. for stirring blades with parallel or radially outwardly diverging edges.

The converting vane edges 8 shown in the drawing are suitably adapted with such a convergence that the stirring blades will give the stirring medium a resulting stirring pulse which is constant throughout the length of the blade. This means that the stirring effect deriving from the stirring blade rotation around the first axis 6 will decrease in the radially outwards direction whereas the stirring effect deriving from the stirring blade rotation aorund the other axis 7 will increase in the radially outwards direction.

The convergence is determined by tests with the stirring medium (media) for which the stirring unit is to be used.

The stirring unit shown in Fig. 4 also has uniform stirring blades 2, 2A, in pairs opposite each other. One pair of stirring blades 2A has, however, an S-like cross section shape which is inversed of the cross section shape of the other pair of stirring blades 2. However, the side edges 8 of both pairs are converging in the radially outwards direction.

For synchronization of the four stirring blades 2, the joint gear wheel 4A has been equipped, e.g. as shown, with two tooth sides for meshing with the gear wheels 3 for the stirring blades 2 and 2A, respectively. In that half the stirring blades of the stirring unit rotate opposite to the other stirring blades during the stirring there will be no appreciable resulting transport of the stirring medium

parallel with the other axis 2 such as will be the case with the arrangement shown in Figs. 1-2. In Fig. 1-2, the stirring medium will, at the direction of rotation shown for the drive shaft 1 and the blades 2 at the cross section shape shown in Fig. 3, receive a moderate resulting action, directed downwards in Fig. 2.

Fig. 5 shows two circles of stirring blades 2 on the same drive shaft 1 where the rotation of the stirring blades 2,2A around the axes 6 is opposite in the two circles. Thus, the stirring effect is fully balanced and will not expose the drive shaft 1 to any appreciable axial power action. If the joint gear wheel 4B for the two circles gave the stirring blades of the circles the same direction of rotation, the pumping effect of the vane mentioned before would be increased by the stirring medium in the drive shaft direction by the number of uniformly rotating stirring blades.

With a view to optimizing delivery time, the design of the stirring unit to the invention aims, for the structure elements involved, at a stirring blade number of revolutions at 75-125%, preferably 100% of the drive shaft revolution number. The drive shaft number of revolutions is determined by the peripheral speed for the radially outermost ends of the stirring blades, and this peripheral speed should not exceed 20m/sec. When calculating the maximal number of revolutions of the drive shaft, the rotation of the stirring blades around the axis 6 is disregarded.

The stirring unit has proved particularly suitable for mixing dough, powdered, paste-like and generally highly viscous masses. Where the stirring unit has radially outwardly converging stirring blades of of an S-like cross sectional shape, it has been shown in practice that with the same mixing effect in a particular stirring medium, you need only use 10% of the energy consumption which used to be attached to the most economical stirring units. Furthermore, baffle plates in the stirring containers may be saved.

For stirring units with a length-width ratio for the

stirring blades of 4:1, stirring blades of simple S-like cross sectional shape may be used, possibly reinforced centrally by a tubular centre part. With a higher length-width ratio for the stirring blades, it will be appropriate to compose the blade cross sectinns from three S-like surfaces or from a triangle cross section from whose triangle corners a longitudinal side comes out, e.g. forming an angle with the adjacebt surface of e.g. 115^{o}.

Due to its design and operation, the double-acting stirring unit will yield a powerful radial pulse to the liquid, e.g. 8 times per drive shaft rotation, due to the fact that each of the stirring blades 2 is at right angles to their guide direction twice per drive shaft rotation at a stirring blade number of four. It must be assumed that this pulse will be of higher intensity than it would have been the case if the blades had been mounted fixed under 90^{o} with the course of the blades. The power transmission between the stirring blades and the stirring medium would then be lost in a powerful turbulence in the stirring medium, and this turbulence would soon be braked by the inner friction of the stirring medium. Unlike this, the double-acting stirring unit to the invention will generate strong pulses which may spread further out in the stirring medium, and thus the number of stirring units may be reduced in comparison with stirring units known so far. This harmonizes with the fact that the stirring unit to the invention has a higher specific performance due to the extra rotation movement for the stirring blades compared to stirring units which have fixed blades or compulsory rotary blades.

Due to the double current principle established by the rotations around the axis 7 and the axes 6, respectively, and the undulating current conditions, it would seem that the double-acting stirring unit is considerably less sensitive to variations in the diameter ratio between the stirring unit spreading diameter and the diameter of the container in which one or more stirring units are placed, than conventional types. Through changes in the number of revolutions and

possibly in the geometric structure, the double-acting stirring unit may be brought to work satisfactorily in the range from 0.1 to 0.9, i.e. that the stirring diameter may vary between 10 an 90 % of the container diameter. This gives a considerably higher flexibility in the application of the stirring unit to the invention.

Figs. 6 and 7 show a wind power machine in the form of a windmill which, as shown, has four rotor blades 2 rotary embedded around their own axis 6, but which are not rotary around the actual windmill axis 7. Between the rotor blades 7 and a central output shaft 10, there is a mechanical arrangement which will not only transmit the rotation of the rotor blades 2 to the output shaft 10, but also to the other rotor blades. Thus, there will always be a positive drive on the output shaft 10, naturally on condition that the rotor blades, like in the case of the stirring unit, are rotary displaced in relation to the neighbouring rotor blades.

The rotor blades 2 are designed in such a manner that the wind finds it harder to pass at one side of the blade centre line than on the other side. The torque thus generated will give the rotor blade a rotating movement. Due to this design of the rotor blades, those of the rotor blades rotated at all times by the rotor blades driving at all times will have a particularly low resistance to the wind in the direction of rotation.

The design aimed at for these rotor blades has been illustrated in Figs. 8 and 9 where the arrows show the wind direction, where the arrow 11 shows the direction of rotation for the rotor blade, where plusses illustrate a driving side at the rotor blade and minusses a suction side or suction effect. When passing over the rotor blade, the kinetic and static energy in the wind given at the side of the rotor blade rotating with the wind is converted into pressure energy at the top side, and by turbulence action into suction effect at the rotor blade bottom side. At the side of the rotor blade rotating against the wind, the air will be unidirectional

as far as possible so that there will be both at the top side and bottom side of the rotor blade an approximate laminar flow entailing a poor resistance to the compulsory rotary movement.

The power action on the rotor blade 2 thus obtained will form a resulting moment which is higher than the moment required to drive the rotor blades driven due to the difference aimed at by the design of the blades between laminar and turbulent flow along the two blade sides.

Any such windmill will not be sensitive to turbulence in the wind. Any such turbulence in the wind will, however, be used effectively through the rotary movement of the particular rotor blades. With the windmill, the peripheral speed for the rotor blades will be decreasing from the axis 7 and out to the tip of the blades contrary to what is the case with the ordinary windmill types. Due to this, the [illegible] blades may be dimensioned considerably easier than usual for you do not have to pay very much attention to the centrifugal forces which are otherwise usually dimensioning together with the bending moment of the particular rotor blades.

Unlike windmills known so far, the vanes or the rotor blades at the windmill to the invention do not require to be adjusted in relation to wind force. In the known windmill systems, the vanes are put more and more on edge at a rising wind force. The interaction between driving and driven rotor blades at the mill to the invemtion will see that the resulting moment is constant so that the number of revolutions for the particular rotor blades remains constant, even at high wind velocities. The risk of the mill racing has thus been considerably reduced.

It will only be necessary to disconnect the mill when the wind forces become so powerful that they constitute an excessive action on the supportingstructure of the mill. At very high wind velocities, it will therefore be appropriate that the mill be organized with a mechanical arrangement entailing that all the rotor blades may be set parallel with

the wind direction for stopping the mill.

As would appear from Fig. 7, the joint gear wheel 40 for synchronization of the reciprocally displaced rotary movements of the rotor blades 2 has been attached to the output shaft 10, the rotation of which is transmitted through a gear transmission 12 down through the vertical supporting structure 14 of the windmill through a drive shaft 15, e.g. for the operation of a dynamo or some other energy consuming equipment. A hydraulic pump may also be in direct mesh with the joint gear wheel 40 so that instead of the output shaft 7, the gear transmisison 12,and the drive shaft 15, hydraulic lines have been conducted to the hydraulic pump at the joint gear wheel 40.

Fig. 10 shows a cross section through an S-like cross section through another stirring blade or rotor blade to the invention of the Savonius type whereas Fig. 11 shows a stirring or rotor blade cross section of the anemometer type.

Fig. 12 shows that even though a stirring blade or rotor blade 2 of converging shape is highly advantageous to the invention, also blades 2 of parallel and diverging shapes will be appropriate for certain applications, e.g. when you do not require a uniform mixture throughout the stirring unit range but e.g. want a heavier mixture at the vane tips.

PATENT CLAIMS:

1. A double-acting stirring unit with a drive shaft (1) and stirring blades (2) placed on this which have beenplaced evenly distributed around the drive shaft with which their longitudinal axes form a predetermined angle of 45-90^{O}, where the stirring blades have been placed in circles opposite each other, where each stirring blade has been rotary embedded around its longitudinal axis, as a first axis of rotation, where each stirring blade has been been rotary embedded near the drive shaft axis which constitutes another axis of rotation where all the beddings of the stirring blades in each circle of stirring blades are attached to the drive shaft for rotation together with this around the other axis of rotation, and where all the stirring blades in each circle through a gear wheel (3) each mesh with a joint hear wheel, characterized in that the joint gear wheel (4) is freely rotary embedded around the drive shaft (1) around said other axis of rotation, and that each stirring blade (2) is rotary displaced in relation to the neighbouring stirring blades and has a cross-section at right angles to its longitudinal axis of rounded or angular S-like shape.

2. A stirring unit according to claim 1, characterized in that the course of each stirring blade has converging side edges away from its bedding place at the drive shaft.

3. A stirring unit according to clam 1 or 2, characterized in that the side edge convergence of each stirring blade (2) for a given S-shape and a given stirring medium has been adapted so that the sum of the velocity of each side edge point around the first and around the other axis of rotation counting vectorially is constant.

4. A stirring unit according to one or more of the preceding claims, characterized in that each stirring blade in a circle of stirring blades has been given the opposite rotation of the neighbouring stirring blades throught the joint gear wheel.

5. A stirring unit according to one or more of the preceding claims, characterized in that it has several circles of

stirring blades placed consecutively on the same drive shaft.

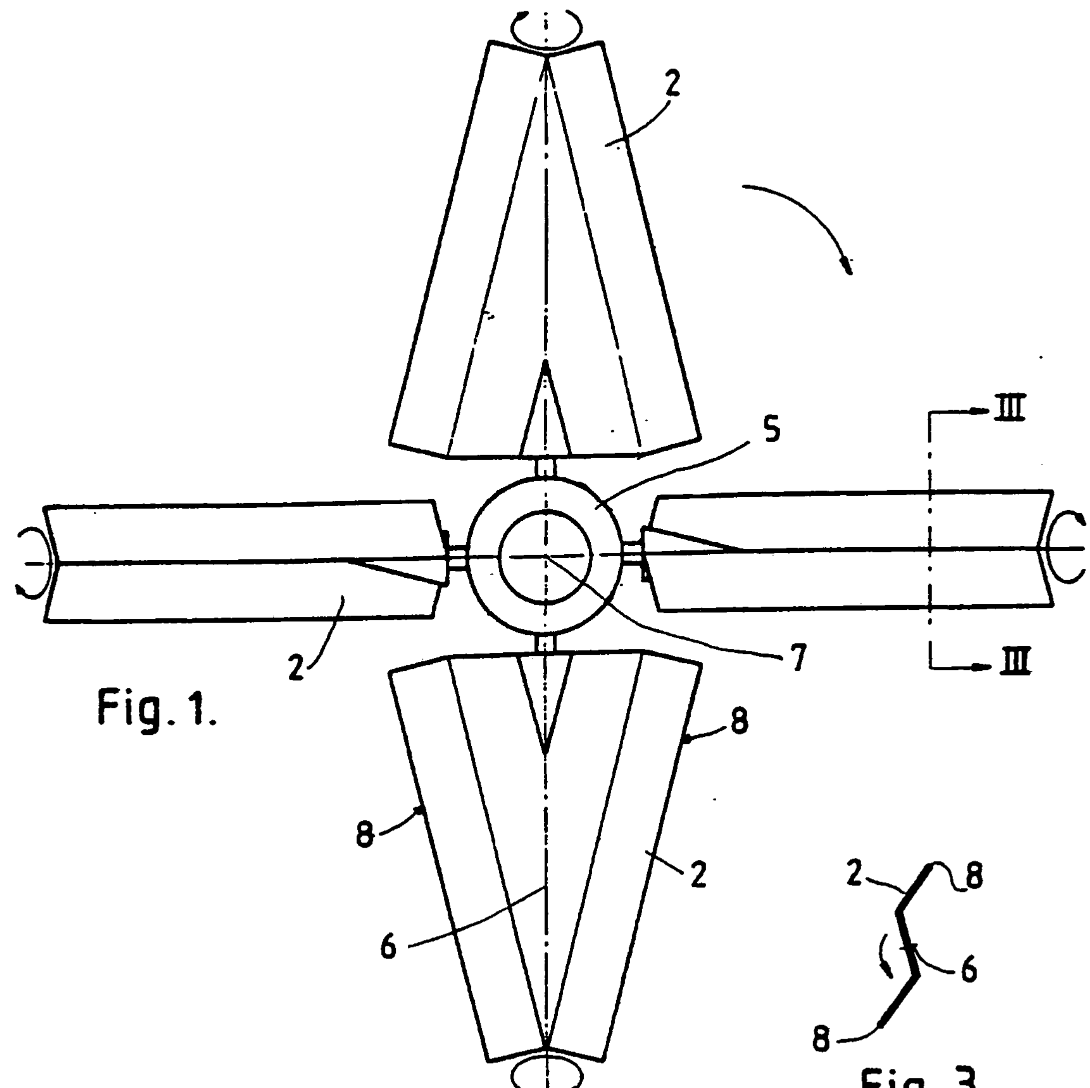

Fig. 1.

Fig. 3.

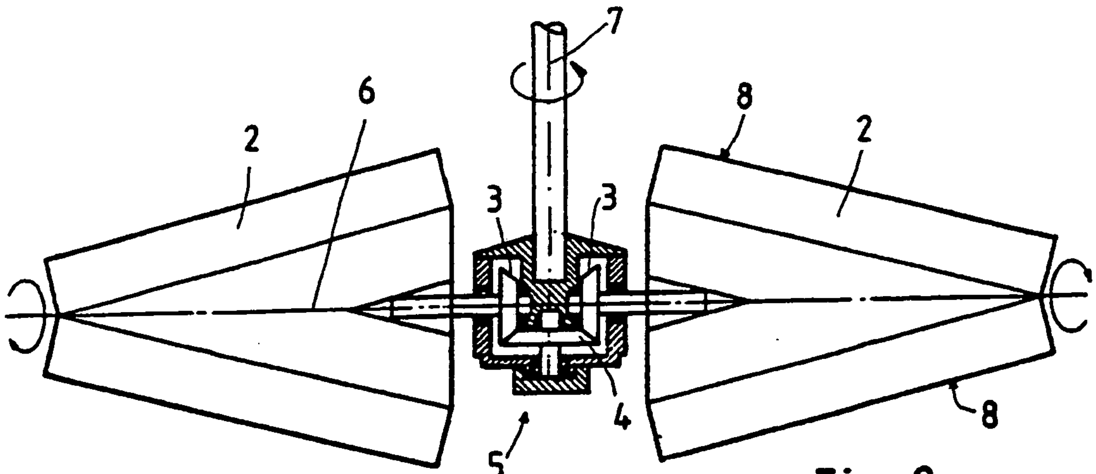

Fig. 2.

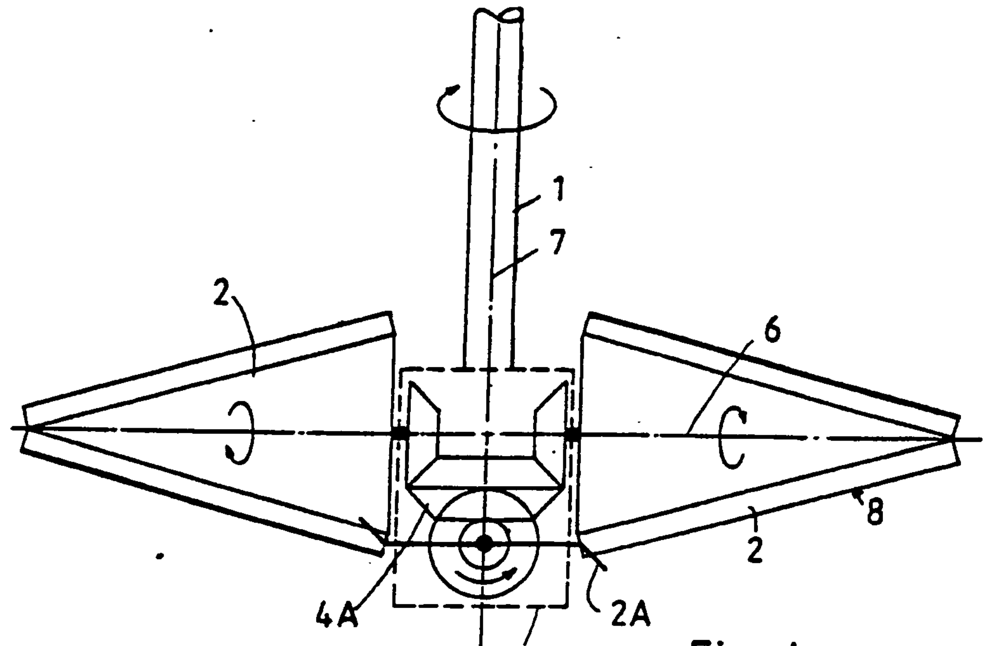

Fig. 4.

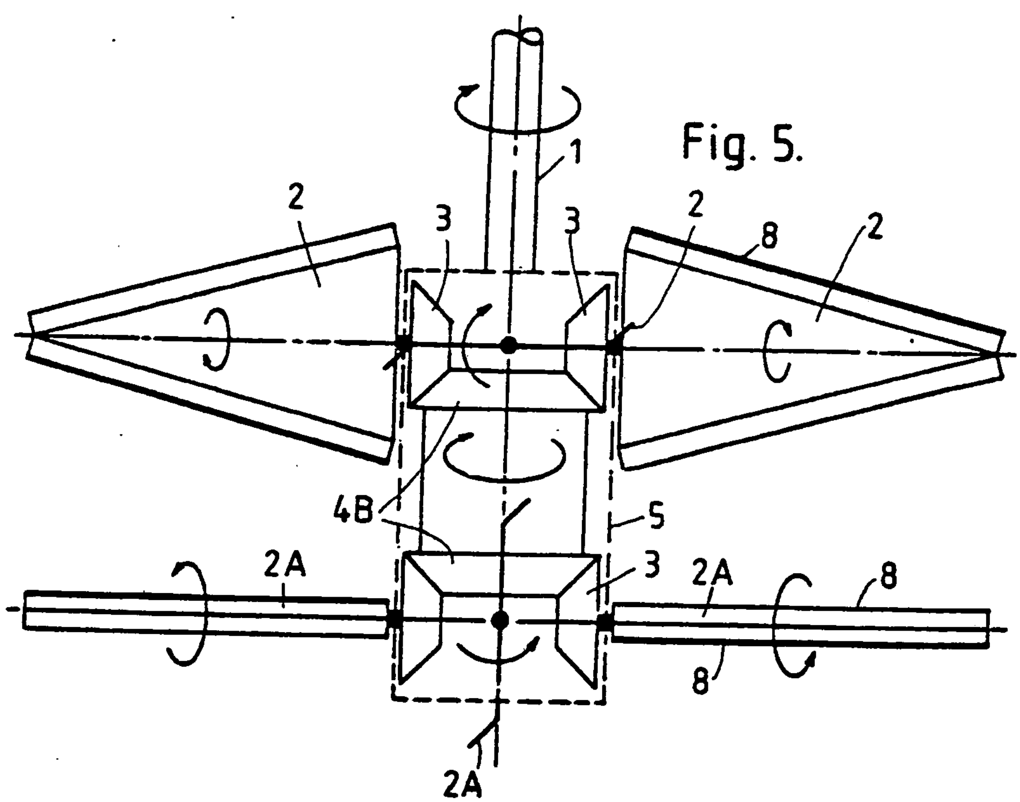

Fig. 5.

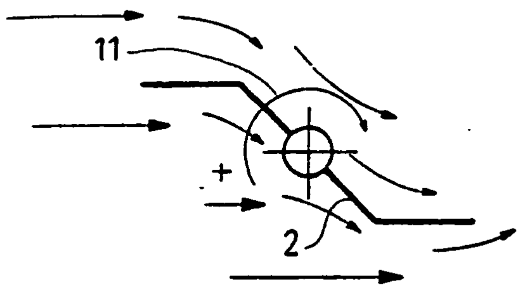

Fig. 8.

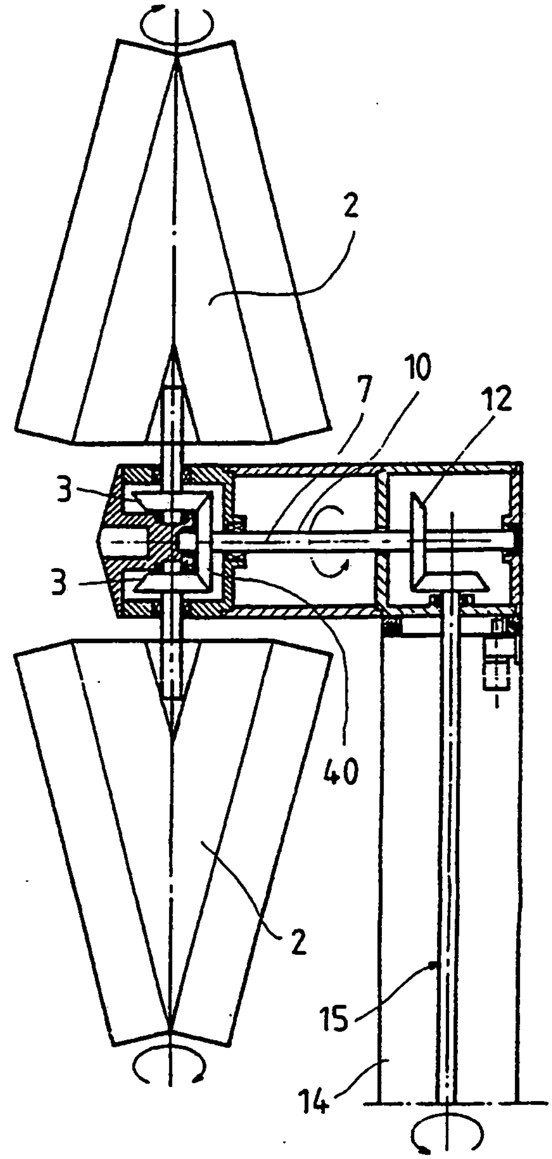

Fig. 7.

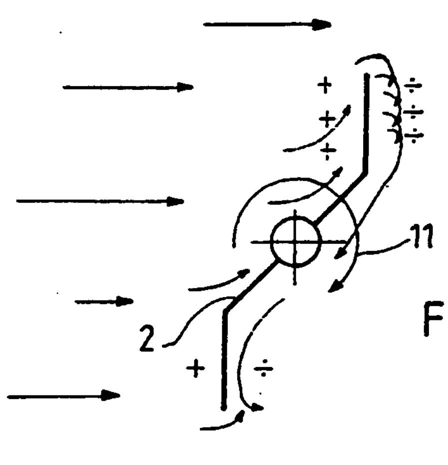

Fig. 9.

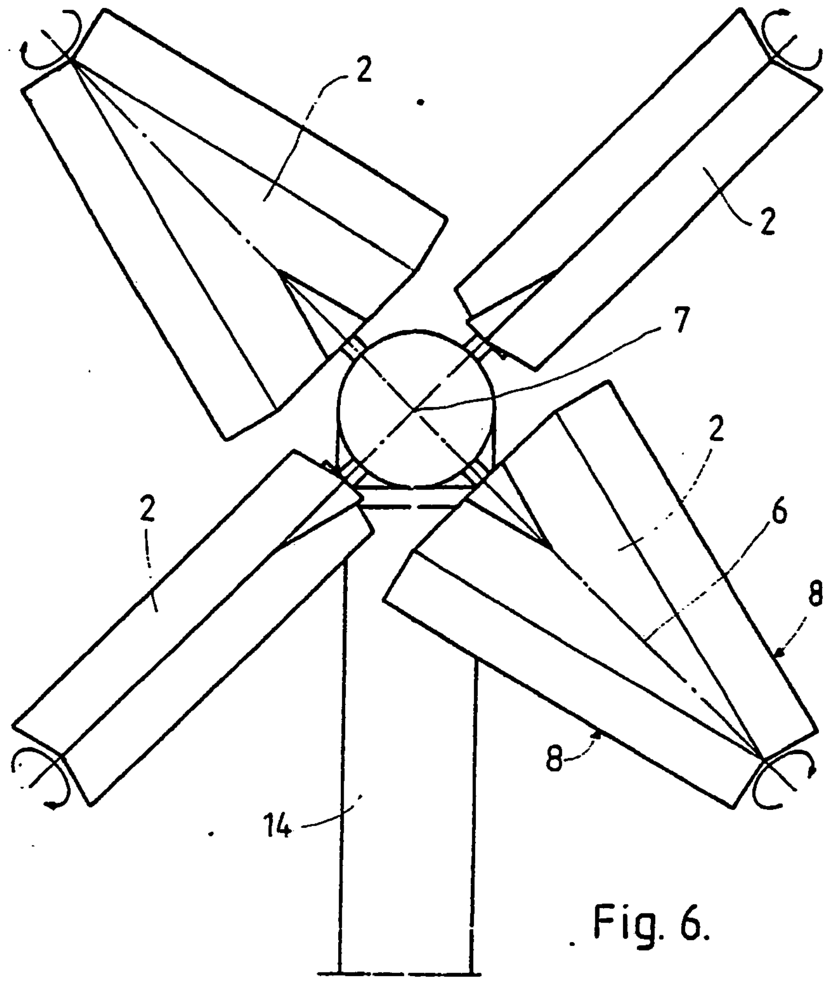

Fig. 6.

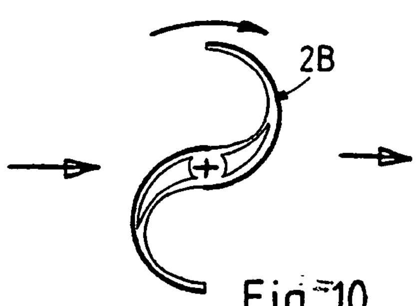

Fig. 10.

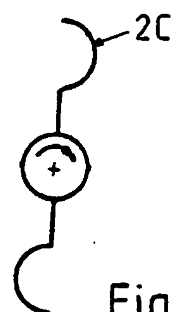

Fig. 11.

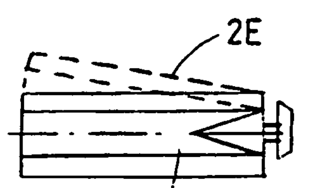

Fig. 12.

INTERNATIONAL SEARCH REPORT

International Application No PCT/DK87/00105

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [8]

According to International Patent Classification (IPC) or to both National Classification and IPC 4

B 01 F 7/04, 7/18

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC 4	B 01 F 7/00-/06, /10, /16-/22, /26, 3/08-/18; B 28 C 5/12-/16
Nat Cl	80a:7/35, /40; 50f:2/30
US Cl	259:5-8,19,21-24,37,40-44,99,102,103,107,108, 112 .../...

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [*]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X	US, A, 1 479 584 (FRANK W CONKLIN) 1 January 1924 See fig 1 and 3	2
X	US, A, 2 905 451 (FREDERICK B CALLANEN) 22 September 1959 See fig 5 and 12	1, 4, 5
A	Derwent's abstract No 92 633 D/50, SU 812 329	1
A	Patent Abstracts of Japan, Vol 8, No 279, C257, abstract of JP 59-147627, publ 1984-08-24	1

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
1987-12-03	1987-12-08
International Searching Authority	**Signature of Authorized Officer**
Swedish Patent Office	Wiva Asplund

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

II Fields searched (cont)

366:64-66, 97-100, 241-261, 342, 343, 349

V.☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE [1]

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1.☐ Claim numbers........., because they relate to subject matter not required to be searched by this Authority, namely:

2.☐ Claim numbers........., because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3.☐ Claim numbers........., because they are dependent claims and are not drafted in accordance with the second and third sentences of PCT Rule 6.4(a).

VI.☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING [2]

This International Searching Authority found multiple inventions in this international application as follows:

1.☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2.☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3.☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

4.☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

☐ The additional search fees were accompanied by applicant's protest.

☐ No protest accompanied the payment of additional search fees.